APPLICATION OF EC02FUMEIM FUMIGANT GAS TO STORED WHEAT IN SEALED STEEL BINS

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Methyl Bromide for grain fumigation will be phased out in the U.S. by January 1, 2001. Alternative rapid fumigation methods are needed by U.S. grain storage, milling and export elevator industries. Aluminum phosphide pellets are slow and unpredictable. Magnesium phosphide releases faster, but are unstable and more expensive than aluminum phosphide.

Although not as fast as Methyl Bromide, a liquid phosphine fumigant called "Phosfume^{TM}" developed by BOC Gases Ltd, Australia is a potential solution. Liquid phosphine is formulated in high pressure cylinders at 2% PH3,98% $C0_2$, or 20g/kg by weight (1994).

Due to a prior U.S. phosphine fumigant copyright, BOC Gases, U.S. is introducing Phosfum^{TM} in the U.S.A. as $EC0_2$FUME^{TM} fumigant gas. ECO_2FUME^{TM} fumigant gas is not temperature dependent, so a fumigation can be conducted quickly at predictable high, medium or low dosages and concentrations in storage or building spaces.

The primary objective of this research was to compare $EC0_2$FUME^{TM} fumigant gas with a leading phosphine pellet, Degesh Phostoxin^{TM} for labeling purposes. Tests compared daily gas levels between minimum dosage rates for commercial steel tanks for Phostoxin^{TM} and $EC0_2$FUME^{TM} fumigant gas targeted at 200 ppm during a 7 day period.

Test were conducted in eleven 1.8 m (6 ft) diameter by 2.7 m (9 ft) high corrugated steel bins assembled on welded steel bases. During bin assembly, special care was used to seal all seams and joints to minimize gas leakage. A 2.4 cm (6 in) diameter flanged transition installed through the sidewall with the transition centerline 2.4 cm (6 in) above the base. Blower mounting adapter plates sealed the transition opening. An inverted "V" duct extends 19 cm (48 in) across the bin from the transition as a gas and aeration duct.

All bins were sealed to hold a half-life of 25 nun (1.0 in) water column for at least one minute as a gas tightness standard. During pressure testing, smoke bombs and soap spray were used to detect leaks. Wall seams, penetrations, and base joints were silicone sealed.

Five bins were equipped with gas piping from the roof cavity to the recirculation blower inlet for fast recirculation of $EC0_2$FUME^{TM} fumigant gas. Five bins were used for Phostoxin^{TM}. Grain temperatures and insects were monitored in an untreated control bin.

Recirculation blowers were rated at 1/1 85th KW (1/250th HP) with a free air capacity of 425 l/min (15 cfm). The blowers delivered about 170-200 l/min (6-7 cfm) through wheat with 40% or 3.1 m^3 (110 ft^3) of void space, providing one gas exchange in 15-20 minutes or three to four gas exchanges per hour. Compared to aeration at 63 liters/T (1/10 cfm/bu) with five minutes per gas exchange or 12 exchanges per hour, these recirculation blowers delivered about 25-21 l/T (1/25th to 1/30th cfm/bu). This is 4 to 10 times normal closed loop fumigation recirculation rates of 6.3-2.1 l/T (1/100-1/250th cfm/bu). (Cook, 1980)

BOC Gases U.S. use 200 ppm +/- 20% as a conservative initial target for $EC0_2$FUME^{TM} fumigant gas dosage rates during the 7 day test. The initial dosage of 1.79 grams of $EC0_2$FUME^{TM} fumigant gas/bin was calculated to produce 200 ppm in the grain interstice space after absorption into 4.6 T (170 bu) of wheat. For Phostoxin™, the minimum dosage level for vertical commercial gram storage recommended by Degesh labels, 150 pellets per 28.3 m^3 (1,000 ft^3), was used. For the 6.4 m^3 (225 ft^3) sealed bins, 34 pellets were probed into the grain mass center in a pattern recommended by a Degesh representative

A bioassay system was installed to evaluate insect mortality. The bioassay chamber was a 2 meter (6.5 ft) by 5 cm (2 in) ID Schedule 40 PVC pipe capped on one end. The horizontal pipe was sealed through a 7 cm. (2.75 in) hole in the bin sidewall, 15 cm (6 in) below the eave, to provide 13-15 cm (5-6 in) of grain cover insulation from headspace heat. Two PVC ball valves 60 cm (24 in) apart were installed in the pipe outside the wall.

A sheet metal roof extension was designed to shield the extended pipe assembly from direct solar radiation to minimize conduction heat transfer into the bioassay pipe. Ibis sun shield reduced internal gas temperatures at the bin wall/pipe interface by about 5-8°C (9-14°F) and reduced temperatures 30 cm (12 in) inside the bin wall by 9-10°C (15-18°F).

Six gas sample and thermocouple test points were installed in the five ECO2FUME'rM fumigant gas bins. Sample points were located: 1) 15 cm (6 in) in and 15 cm (6 in) up from the base opposite the blower-, 2) 15 cm (6 in) in and 15 cm (6 in) up from the base 90 degrees from the blower centerline; 3) grain mass center -- 90 cm (36 in) from sidewall, 110 cm (44 in) above base; 4) 15 cm (6 in) in and 15 cm, (6 in) down from top of sidewall directly above point #2; 5) in gas recirculation pipe 15 cm (6 in) above blower inlet; 6) in the bioassay tube, 7.5 cm (3 in) outside the bin wall.

Gas and temperature sampling points on the Phostoxin'74 bins and the control bin were the same as the $EC0_2$FUME™ fumigant gas bins except for point #5. Only temperatures were recorded for the check bin. During the seven day test, average gas levels for the four grain sample points in $EC0_2$FUME™ fumigant gas bins ranged from 274 to 131 ppm. Levels for Phostoxin™ bins ranged from 759+ ppm (some points exceeded 1200 ppm) to 94 pprn.

Phostoxin™ bins received an initial dose of 6.8 gm PH_3 per bin. ECO_2FUME™ fumigant gas bins received an initial dose of 1.79 gm of PH_3 per bin plus an average redose of 1.80 gm per bin, for a total of 3.59 gm per bin. The total minimum to maximum dosage for $EC0_2$FUME™ fumigant gas ranged from 3.26 to 3.89 gm. The total average dosage required to maintain the target gas level for the ECO_2FUME™ fumigant gas bins was 52.9 percent of minimum recommended dosage for phosphine pellets.

Leakage rates from the $EC0_2$FUME™ fumigant gas bins based on gas redosage values ranged from 2.52 ppm/hour to 3.60 ppm/hour and averaged 3.02 ppm/hour during the first 117 hours of testing.

References:

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